Project

Rohith Jayarajan

(*e-mail:* `rohith23@terpmail.umd.edu`)

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1 Problem Definition

Given a video of a mobile cart moving up and down on a door, the objective of the project is to identify the door and the cart in the video and track the movement of the cart.

The input video consisted a cart, predominantly white in color, which moves in a zig-zag manner on a grey colored door. The cart also has three red color LED's on its body.

2 Assumptions

Following were the assumptions on which the project was built and are reasonable for any similar problem in the given environment

1. The color of the door is always same as given in the input video.
2. The dimensions of the door is always approximately the same as given in the input video.
3. The cart always moves only on the area of door mentioned above and never on the adjoining wall.
4. The color of the LED's always remain the same (Red) for the cart.

3 Approach and Methods Used

The problem of identifying the door and the cart and tracking the cart was successfully solved using three different approaches and are mentioned below with the pipeline used.

3.1 Method 1: Image Processing and Bounding Rectangles

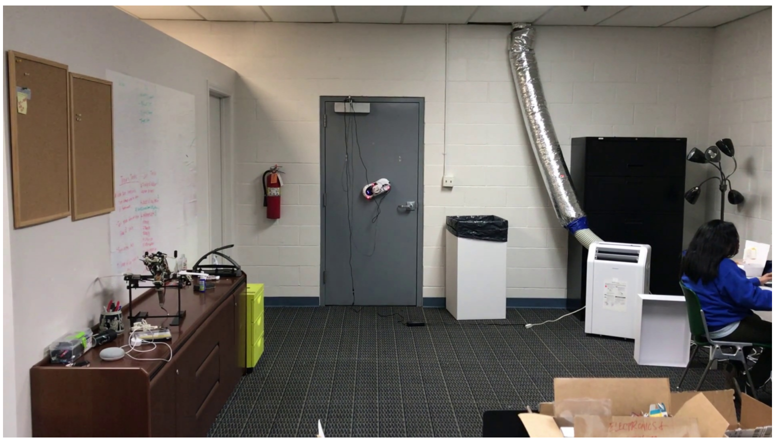

Fig. 1. Frame in RGB

3.1.1 Detection of the Door

1. To detect the door, the prior knowledge of the color of the door and the assumption of color constancy of the door is used.

2. The frame of the input sequence was experimented with and converted to various color spaces and was concluded that the best color space to detect the door was HSV color space.

Fig. 2. Frame in HSV

3. To make the detection of the door more robust, processing was not only done in the HSV color space but also in the RGB color space. Using image processing and morphological operations, a combination of RGB and HSV masks were used. This gives a mask as shown in figure 3

Fig. 3. The ”door” mask

4. Contours of this mask were found using cv2.findContours. The assumption that the dimensions of the door is always approximately the same comes in use here. In this particular image sequence, the distance of the door from the camera almost remains constant, hence the contour within a certain range of area was declared as the door. If the distance between the door and camera changes, a modification to use the aspect ratio of the door can be easily used to replace the area condition.

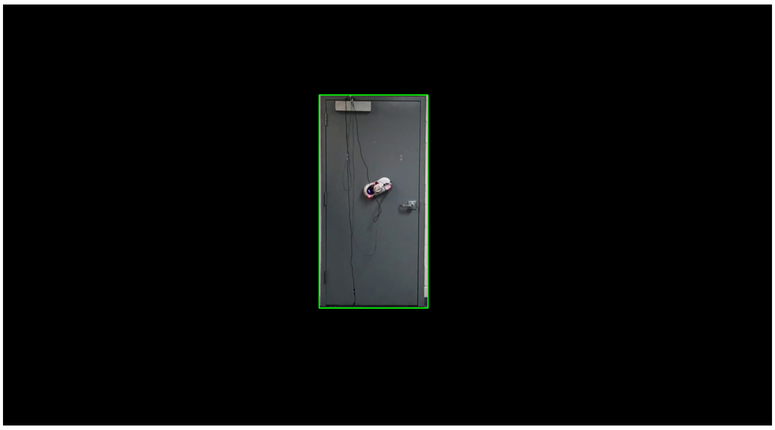

Fig. 4. Successful Detection of the Door

5. Now that a mask for the door has been designed, a rectangular bounding box of green color is used to identify the door as shown in figure 4
6. For the input video sequence, a 100% accuracy has been achieved to detect the door.

3.1.2 Detection and Tracking of the Cart

1. The detection of the door has made the task of detecting the cart and its tracking much simpler due to the assumption that the cart only moves up and down the door.
2. Based on the knowledge that the cart has three Red color LED's which form a triangle with its centroid always lying on the cart, image processing is used to detect the LED's as shown in figure 5.

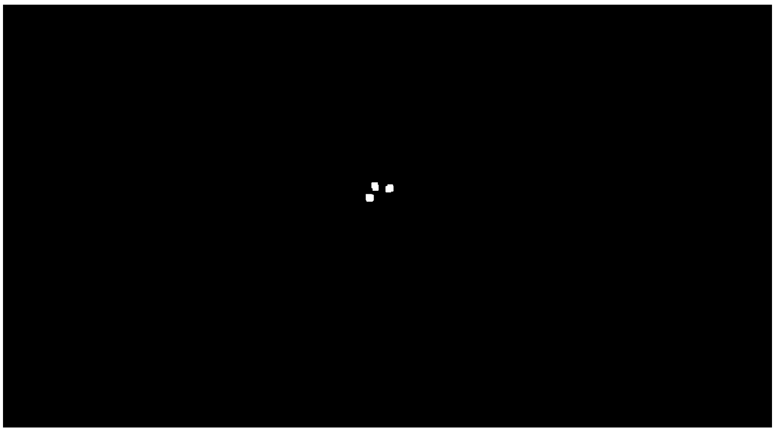

Fig. 5. Mask to Detect LEDs of the Cart

Now to perform tracking on the cart, using bounding boxes given by the contours help to design a basic tracker for the cart. An accuracy of 100% is achieved for detection and tracking of the cart as at all frames, the algorithm correctly shows the bounding box of the cart in green. The final output can be viewed in the video named ”TrackerV1” and a snapshot of the output is shown in figure 6.

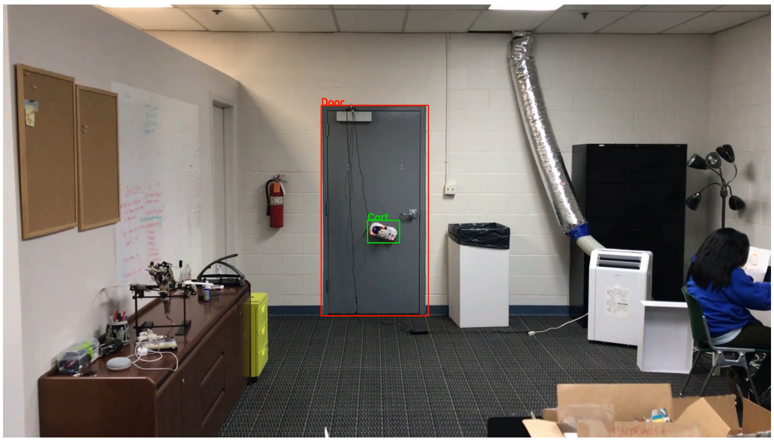

Fig. 6. Detection and Tracking Output

3.2 Method 2: Mean Shift Tracking

All the image processing pipeline from Method 1 is the base for this method.

At the start of the video processing stage for detection and tracking of the cart, a provision has been made for the user to define a bounding box on the object that is to be tracked, in this case the cart. Once the ROI (Region of Interest) has been given, the Mean Shift Tracking algorithm is implemented to track the cart in the video sequence.

The output of the Mean Shift Tracker can be viewed in the video named ”TrackerV2”.

3.3 Method 3: Cam Shift Tracking

The drawback of the Mean Shift Tracking algorithm is that the size of the bounding box over the tracked object is always of the same size. To overcome this, a Cam Shift Tracker has been implemented to show a dynamic bounding box.

The output of the Cam Shift Tracker can be viewed in the video named ”TrackerV3”.

4 Conclusion

In the above methods experimented on, Method-1 gives an output that has high precision. The outputs of Method-2 (Mean Shift Tracking) and Method-3 (Cam Shift Tracking) depend on the tightness of ROI specified by the user.

References

[1] OPENCV documentation.

[2] Dataset provided by Radii Robotics.